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ADL-72580-5

ADDENDUM TO

TECHNICAL REPORT 5

DOG-LEG UNMASKING IN THE CORRECTED-INTERCEPT MODE

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ADDENDUM TO ADL-72580-5, TECHNICAL REPORT 5,
"DOG-LEG UNMASKING IN THE CORRECTED-INTERCEPT MODE",
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INTRODUCTION

The results reported in Technical Report 5 were obtained by using the computed value of $\hat{U}_r$. The computations were repeated for the same runs and cases when $\hat{U}_r = 0$ is used. The results are presented and discussed below.

RESULTS AND CONCLUSIONS

The results are tabulated in Tables 1 - 5, the results for run 1 in Table 1, etc. The acquisition probabilities in a column are the values obtained for a particular run and case for the 18 combinations of δ, f_1, and f_2. The highest value and others within .02 of the highest are underscored to make it easier to see where the high values occur.

The computations were terminated prematurely in some cases, which are marked (a) in the tables, when the "passage" test that is used in the program went positive on the dog leg. This is a program limitation, not a control limitation. It can be removed by starting the passage computation after the dog leg has been completed, at the risk of not detecting an earlier valid passage that could occur on the initial leg when the range has been overestimated by a large factor. A better solution is to make the computations on the initial leg and then jump to the time at which the turn from the dog leg is completed to continue the computations.

The premature termination occurred primarily in case 1 (turn at middle of second tracking leg) of runs 1 and 3. It did not occur when $\hat{U}_r$ was computed, instead of assumed to be zero, because the acceptance test on the magnitude of $\hat{U}_r$ prevented the solution from being accepted until 5 tracking legs had been run. When $\hat{U}_r = 0$ is used, acceptance occurs with 3 tracking legs. The acquisition probabilities that were obtained

when the computations were terminated prematurely are not valid and have not been listed in the tables. The omission of these cases, which amounts to approximately 10 percent of the total, does not affect the general conclusions obtained from the analysis.

The conclusions reached from a study of the results in the tables and those reported in Technical Report 5 are as follows:

(1) The direction of the turn to the dog leg should be determined from the sign of $\hat{U}_b$, that is, to the right (left) when $\hat{U}_b$ is positive (negative). This conclusion is the same as that reached when $\hat{U}_r$ is computed.

(2) The initial leg should be in the range of 20 to 30 percent of the estimated range of the target. The optimal value of f_1 is somewhat smaller with $\hat{U}_r = 0$ than the optimal value with $\hat{U}_r$ computed. A value of f_1 near 0.25 is indicated.

(3) The dog leg should be continued for only a short time after unmasking occurs. When this time is put equal to f_2T, where T is the smoothing time, the optimal value of f_2 is less than 1.0 for most of the runs and cases and may be less than 0.5. With the value of T = 20 seconds used in the computations the optimal time after unmasking is very small. It is enough to ensure one correction, but perhaps not many more, before masking recurs. The optimal value of f_2 for $\hat{U}_r = 0$ is smaller than the optimal value of f_2 for $\hat{U}_r$ computed.

(4) The acquisition probabilities obtained with $\hat{U}_r = 0$ are generally higher than those obtained with $\hat{U}_r$ computed, but not in all cases. On balance, the choice of $\hat{U}_r = 0$ is preferred. The choice is more definite now than it was before the modifications were made to the dog leg.

Conclusion (1) is apparent from the positions of the underscored probabilities in the tables, and the fact that $\hat{U}_b$ is positive except in cases 1 and 2 of runs 3 and 4. The optimal direction of the turn is in agreement with the sign of $\hat{U}_b$ in all cases in which there is a clear-cut

choice, except case 1 of run 2. Case 1 of run 1, which is not included here, also was an exception with $\hat{U}_r$ computed.

It is apparent that the optimal values of f_1 and f_2 with $\hat{U}_r = 0$ are smaller than the values, $f_1 = 0.3$ and $f_2 = 1.0$, that give good results for most of the runs and cases when $\hat{U}_r$ is computed. These changes are in the direction that is indicated by interception analysis. The effect that the value of $\hat{U}_r$ has on the lead angle depends on the angle between the sight lines from the target submarine to the tracking submarine and to the torpedo guide point. This angle is reduced by reducing f_1 and f_2, particularly f_2. Hence, it is to be expected that the optimal values of f_1 and f_2 will be smaller with $\hat{U}_r = 0$ than with $\hat{U}_r$ computed.

The preference for $\hat{U}_r = 0$ over the computed value is more definite with the revised dog-leg procedures than it was before the modifications were made. Also, when $\hat{U}_r = 0$ is used, there are fewer cases in which better results are obtained with no post-launch control than are obtained with control. The sole exception is case 1 of run 2. By contrast, when we use the computed value of $\hat{U}_r$, no control yields better results than control in cases 1 and 2 of runs 2, 3, and 4.

TABLE 1. EFFECTS OF INITIAL LEG AND UNMASKING TURN AND LEG
RUN 1 (60 DEGREES TURN AWAY)

			Acquisition Probabilities				
δ	f_1	f_2	case 1	case 2	case 3	case 4	case 5
+1	0.2	0.5	(a)	.53	.58	.60	.55
		1.0	(a)	.49	.57	.58	.56
		1.5	(a)	.52	.54	.56	.58
	0.3	0.5	(a)	.45	.59	.58	.60
		1.0	(a)	.53	.55	.58	.60
		1.5	(a)	.46	.54	.56	.58
	0.4	0.5	(a)	.43	.51	.53	.56
		1.0	(a)	.38	.56	.56	.54
		1.5	(a)	.50	.55	.55	.56
-1	0.2	0.5	(a)	.48	.47	.52	.46
		1.0	(a)	.46	.48	.49	.53
		1.5	(a)	.47	.46	.49	.51
	0.3	0.5	(a)	.39	.45	.47	.52
		1.0	(a)	.46	.43	.47	.52
		1.5	(a)	.39	.44	.45	.49
	0.4	0.5	(a)	.32	.40	.44	.48
		1.0	(a)	.45	.38	.42	.46
		1.5	(a)	.43	.42	.45	.48

Note (a): Computations terminated prematurely when "passage" test went positive on the dog leg; this is a program limitation that will be removed.

TABLE 2. EFFECTS OF INITIAL LEG AND UNMASKING TURN AND LEG
RUN 2 (60 DEGREES TURN TOWARDS)

δ	t_1	t_2	Acquisition Probabilities case 1	case 2	case 3	case 4	case 5
+1	0.2	0.5	.65	.79	.72	.72	.69
		1.0	.68	.76	.73	.72	.70
		1.5	.70	.76	.74	.73	.71
	0.3	0.5	.72	.79	.76	.75	.73
		1.0	.70	.76	.73	.73	.71
		1.5	.67	.76	.74	.73	.72
	0.4	0.5	.47	.72	.76	.74	.66
		1.0	.44	.77	.75	.73	.71
		1.5	.40	.76	.71	.70	.69
-1	0.2	0.5	.76	.75	.72	.70	.66
		1.0	.74	.71	.71	.69	.67
		1.5	.72	.74	.71	.68	.66
	0.3	0.5	.74	.73	.70	.68	.65
		1.0	.67	.72	.68	.67	.65
		1.5	.59	.71	.67	.66	.64
	0.4	0.5	(a)	.71	.68	.66	.63
		1.0	(a)	.70	.65	.64	.62
		1.5	(a)	.70	.61	.63	.61

Note (a): Computations terminated prematurely when "passage" test went positive on the dog leg; this is a program limitation that will be removed.

TABLE 3. EFFECTS OF INITIAL LEG AND UNMASKING TURN AND LEG
RUN 3 (120 DEGREES TURN AWAY)

δ	f_1	f_2	Acquisition Probabilities				
			case 1	case 2	case 3	case 4	case 5
+1	0.2	0.5	.49	.38	.57	.58	.43
		1.0	(a)	.38	.55	.57	.46
		1.5	(a)	.37	.52	.55	.57
	0.3	0.5	(a)	.35	.56	.58	.50
		1.0	(a)	.33	.54	.56	.52
		1.5	(a)	.33	.52	.55	.58
	0.4	0.5	(a)	.32	.54	.50	.55
		1.0	(a)	.31	.52	.56	.52
		1.5	(a)	.31	.51	.54	.55
-1	0.2	0.5	.47	.45	.44	.52	.38
		1.0	.35	.44	.51	.55	.53
		1.5	.27	.42	.49	.54	.55
	0.3	0.5	(a)	.44	.46	.52	.51
		1.0	(a)	.43	.46	.52	.56
		1.5	(a)	.41	.46	.50	.55
	0.4	0.5	(a)	.41	.44	.51	.56
		1.0	(a)	.32	.42	.46	.52
		1.5	(a)	.40	.31	.44	.51

Note (a): Computations terminated prematurely when "passage" test went positive on the dog leg; this is a program limitation that will be removed.

TABLE 4. EFFECTS OF INITIAL LEG AND UNMASKING TURN AND LEG
RUN 4 (120 DEGREES TURN TOWARDS)

			Acquisition Probabilities				
δ	f_1	f_2	case 1	case 2	case 3	case 4	case 5
+1	0.2	0.5	.78	.81	.75	.73	.60
		1.0	.56	.80	.73	.73	.61
		1.5	.56	.80	.73	.71	.69
	0.3	0.5	.53	.79	.75	.72	.66
		1.0	.36	.78	.73	.72	.64
		1.5	.36	.77	.71	.72	.70
	0.4	0.5	.34	.70	.72	.72	.71
		1.0	.20	.66	.72	.71	.69
		1.5	.21	.67	.70	.69	.68
-1	0.2	0.5	.80	.82	.73	.73	.61
		1.0	.70	.80	.70	.72	.68
		1.5	.64	.79	.70	.70	.68
	0.3	0.5	.79	.81	.69	.69	.69
		1.0	.54	.78	.67	.69	.67
		1.5	.48	.76	.64	.67	.66
	0.4	0.5	.33	.79	.53	.60	.67
		1.0	.29	.72	.50	.59	.66
		1.5	.25	.68	.54	.57	.63

TABLE 5. EFFECTS OF INITIAL LEG AND UNMASKING TURN AND LEG
RUN 5 (DECELERATE AND ACCELERATE)

δ	f_1	f_2	Acquisition Probabilities case 1	case 2	case 3	case 4	case 5
+1	0.2	0.5	.66	.68	.69	.68	.66
		1.0	.65	.68	.67	.67	.67
		1.5	.65	.67	.66	.66	.66
	0.3	0.5	.67	.68	.68	.66	.69
		1.0	.65	.67	.68	.67	.67
		1.5	.65	.66	.66	.66	.66
	0.4	0.5	.64	.66	.64	.66	.63
		1.0	.63	.62	.66	.65	.64
		1.5	.61	.60	.65	.65	.64
-1	0.2	0.5	.60	.61	.60	.61	.59
		1.0	.59	.61	.60	.60	.60
		1.5	.57	.60	.58	.58	.58
	0.3	0.5	.57	.55	.56	.57	.58
		1.0	.56	.59	.57	.57	.57
		1.5	.54	.56	.55	.55	.56
	0.4	0.5	.56	.58	.54	.54	.56
		1.0	.54	.54	.55	.55	.56
		1.5	.52	.52	.53	.53	.54

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13. ABSTRACT

A dog-leg turn may be used to unmask the target and obtain post-launch tracking data for the computation of control orders. The timing and direction of the turn, and the length of the dog leg, are examined to determine the sensitivity of the acquisition probability to these variables in the corrected-intercept mode. The length of the dog leg is computed in a way that assures that unmasking will occur and that at least one correction will be applied to the gyro course before masking recurs. Rules are determined for the computation of the length of the initial leg, the direction of the turn, and the length of the dog leg.

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